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Edited by Jeanette Altarriba and Ludmila Isurin

Excerpt

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## Introduction

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*Jeanette Altarriba and Ludmila Isurin*

Recent decades have seen a marked increase in the study of bilingualism from a scientific, empirical perspective, with the publication of various works that speak to the breadth of this subject area and the many different kinds of approaches that can be involved within this endeavor (see e.g., Altarriba & Heredia, 2008; Bhatia & Ritchie, 2005; de Groot & Kroll, 1997; Doughty & Long, 2003; Heredia & Altarriba, 2002; Randall, 2007). The purpose of the current volume is to provide a combined theoretical/applied approach to second language learning, use, and processing from a cognitive viewpoint. The chapters are meant to inform the reader regarding the relationship between memory and language, as grounded in cognitive paradigms, theories, and experimentation. The aim is not only to present results regarding various issues in bilingual language processing, but to educate the reader on the relationship between theory, cognitive experimentation, and data, and their role in understanding language learning and practice.

While psycholinguists and cognitive psychologists have extensively studied the role of memory in language processing, there remains a void in the literature as to how those studies have direct bearing on applied issues and applied areas of inquiry. That is, often times, the field of language and memory focuses either on empirical approaches or on applied approaches, but does not seek to meld or otherwise demonstrate the connections between these two perspectives. The present volume is aimed toward filling this current void.

Moreover, this volume broadens the boundaries of single disciplines and brings in cognitive, psycholinguistic, neurolinguistic, educational, and applied linguistic perspectives. From chapters on recent advances in research on bilingual memory to studies on the role of the brain in language processing, from chapters on working memory in second language acquisition (SLA) to applied investigations of SLA, from chapters on the role of memory in retaining linguistic information to those on first and second language forgetting, this volume targets a

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broad audience of readers and is easily accessible to anyone interested in these topics. In addition to its remarkable interdisciplinary spirit, the volume's strength is in the balanced combination of theoretical/overview contributions and accounts of novel, original, empirical studies.

The volume opens with a chapter on bilingual memory, memory structure, access, and processing (Chapter 1). Bartolotti and Marian provide an extensive overview of the research on bilingual memory. The major focus of the review is on the architecture of bilingual memory and the mechanisms involved in memory access and processing. The authors discuss the accumulated evidence related to the nature of those mechanisms, that is, whether they are language dependent or language independent. The chapter concludes with a discussion of a few models of bilingual memory, and the authors pinpoint the significance and possible shortcomings of these models.

The next chapter (Chapter 2) is a logical continuation of the discussion of bilingual memory models. Dijkstra and colleagues provide an extensive overview of research on lexical competition in localist and distributed connectionist models of second language (L2) acquisition, give an account of the extant models of L2 acquisition, and demonstrate how these models can be simulated in order to understand the way that new L2 words enter the mental lexicon and how human memory overcomes a competition between the L1 (first language) and L2 lexicon. The authors argue that each model highlights different aspects of acquisition of L2 vocabulary. The chapter concludes with a theoretical comparison of various models.

From more general models of bilingual memory to more specific memory components, the volume proceeds to a closer look at the role of working memory (WM) in bilingual language acquisition and processing. This issue is addressed by two contributions. First, the chapter by Szmalec and colleagues (Chapter 3) discusses the latest research on working memory and its role in L2 acquisition. It opens with a brief overview of the history of research on WM, major theories, and experimental paradigms. The authors discuss the role of verbal memory in the learning of new words and show how prior findings from the monolingual literature led to more recent studies on bilingual memory. Then the authors offer the most recent findings on the role of WM in lexical access and syntactic processing and discuss how bilingualism influences WM performance.

The next chapter on the role of WM in bilinguals (Chapter 4) takes the reader into the fascinating and barely researched area of simultaneous interpreters. Signorelli and Obler's contribution on WM advantages in simultaneous interpreters gives a detailed account of the

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extant studies in which cognitive differences between interpreters and non-interpreters are explored. The authors start their review with a discussion of the recent models of WM, especially the importance of the phonological loop and the episodic buffer as it relates to the highly demanding task of simultaneous interpretation. The review of the 13 studies pertaining to the field is broken down along a number of lines, that is, findings on WM advantages in interpreters versus those that only indicate the directionality of the effect, types of tasks and stimuli, as well as methodological variations found in the literature. The authors argue that the emergent evidence of the interpreter's cognitive advantage would have been much stronger had the inconsistencies and discrepancies in the reported studies been eliminated.

The contribution by van Hell and Kroll (Chapter 5) extends the discussion of memory paradigms into the field of electrophysiological studies on bilingual memory. The authors give a thorough overview of the findings obtained through the use of translation paradigms in the study of bilingual memory. Then they bring together the evidence from behavioral and electrophysiological studies and show how the two approaches complement and challenge each other. The chapter concludes with an outline of new directions in which the merger of the two subfields should go and what additional factors should be considered in future studies on bilingual memory.

The following two chapters look at age factors as related to second language acquisition and memory changes. The first contribution by Trofimovich and colleagues (Chapter 6) reports on a study looking into explicit and implicit memory dissociation in adults and children. The authors add a new angle to the debate of the critical period as a major adverse factor in adults' learning of a second language. Is the age factor solely responsible for children's higher achievements in L2 learning? In the experimental study probing into explicit and implicit processing among four age-matched groups of participants – native speakers of English and native speakers of French/second language learners of English – Trofimovich and colleagues pursue two goals: (1) to establish any experimental dissociations between explicit and implicit memory due to experimental processing manipulations; and (2) to test for a developmental dissociation between explicit and implicit memory.

In her contribution on aging in bilinguals (Chapter 7), Goral brings in the evidence on linguistic and cognitive changes related to age. The field of bilingualism does not have sufficient empirical evidence regarding the factors that influence the reported decline of both languages in the individual; neither do we have enough knowledge concerning

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the general decline of bilinguals' cognitive skills. The author gives an extensive overview of the extant findings related to the field and suggests directions for future research.

The next two contributions discuss the role of memory and cognition in two areas of research that have been growing over the past two decades. The chapter by Altman and colleagues (Chapter 8) provides insight into the autobiographical memories of bilinguals. Along the existing lines of research on autobiographical memories, the authors investigate the traditional "reminiscence bump" in English–Hebrew bilinguals' memory. However, they add a few additional angles, such as the existence of another reminiscence bump which is related to the years surrounding immigration, "crossover memories" – that is, memories retrieved in a language different from the language in which the memory was recorded – and code-switching in autobiographical memories.

The next area of research on bilingual memory and cognition relates to the renewed interest in the Linguistic Relativity Hypothesis. The question of a unique perspective of the world in bilinguals is discussed in the contribution by Athanasopoulos and Avelo (Chapter 9). The authors give an overview of the evidence gathered over the last decade through experimental research within the framework of the Linguistic Relativity Hypothesis. They focus on a few directions of the research in the field, that is, color terms, grammatical number, and aspect realization in verbs of motion. The chapter discusses those factors that showed effects in the reported studies, such as L1 and L2 proficiency level, age of L2 acquisition, maturational constraints, amount of exposure to either of the bilingual's languages, the language of instruction in the experimental study, and the general integration in the L2 socio-cultural environment. The authors raise the question of memory involvement in the formulation of the bilingual's perceptions of the world.

The volume continues with an applied approach to the study of bilingual memory in foreign language acquisition (Chapter 10). Tse and Pu discuss the study of the acquisition of a third language vocabulary via two different routes: repeated study versus repeated testing. Through a thorough discussion of the accumulated theoretical and empirical knowledge on bilinguals' memory and acquisition of foreign language vocabulary, they build a background for testing their hypothesis. The acquisition and retention of a third language (L3) vocabulary through the L2–L3 association was shown to be stronger when the study–test procedure was used versus study alone. The study also provided evidence of the importance of L2 proficiency as a factor in the acquisition of L2 vocabulary through this paradigm.

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Memory research in the field of bilingualism is inseparable from studies on language forgetting – native and foreign – in healthy individuals. The review chapter on L2 attrition by Bardovi-Harlig and Stringer (Chapter 11) expands the conceptual framework of research on L2 attrition by looking more closely at the lexicon as the most vulnerable part in language attrition. They argue that lexical storage in memory goes beyond the traditional lexical forms and incorporates certain syntactic elements as well as idioms and conventional expressions. In their comprehensive overview of research done in the field of linguistics and cognitive psychology, they attempt to bridge the two fields and conceptualize a new approach to the study of L2 attrition.

The contribution on first language attrition by Isurin (Chapter 12) reports on an empirical study of lexical access in Russian–English bilinguals who come from three distinct second language environments. Linguistic and socio-linguistic factors, such as word frequency, amount of language exposure, and length of residency in the host country, are analyzed quantitatively, whereas the effect of the second language in assigning alternative names to pictures, naming objects in the wrong language, and confusion with lexically convergent/divergent concepts is analyzed qualitatively. The author argues for the importance of combining both methods of analysis in studies of bilingual lexical access.

The volume concludes with Altarriba's overview (Chapter 13) of the main findings across the current set of chapters, with an eye toward questions and areas of research inquiry that naturally flow from these chapters. A discussion of future research directions in the field of bilingual memory focuses on such new and novel areas as the role of emotion processing within and across languages, the relationship between bilingualism and creativity, the representation of figurative language among bilingual populations, and the role of orthography or “scripts” in the encoding, maintenance, and retrieval of information from bilingual memory. These and many other areas of investigation are commented upon, reviewed, and posed for the reader in an effort to stimulate new and future research that combines aspects of bilingualism, language, and memory.

It is our hope as editors that *Memory, Language, and Bilingualism: Theoretical and Applied Approaches* will be viewed as timely, novel, and highly informative. This volume should serve as a handy, state-of-the-art compendium and reference text for researchers, scientists, and those interested in knowing more about extant findings in this area of investigation, as well as a resource for related courses at various levels of instruction. Moreover, it was compiled so as to engage an audience

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that is broader than that typically associated with the fields of cognitive science and cognitive psychology – an audience that should include individuals in education, other social sciences, computer science, and artificial intelligence, and several other related fields.

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# 1 Bilingual memory: structure, access, and processing

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*James Bartolotti and Viorica Marian*

## Abstract

Language and memory are closely intertwined in the human cognitive architecture. Language acquisition depends on successful memory encoding and retrieval; at the same time, language itself is instrumental for encoding and storing knowledge. For bilinguals, the need to keep their two languages functionally distinct influences memory. In this chapter, we review the *structure* of bilingual memory, including long-term, short-term, and phonological working memory and how they are influenced by knowledge of multiple languages. We also investigate memory *access* and review research on episodic memory access in bilinguals and on semantic memory access during bilingual language comprehension and production. We then examine *processing* in the context of existing models of bilingual language and memory. Finally, we consider how the prism of novel language learning can provide insight into the interaction between memory and language. We conclude that bilingualism changes the human cognitive architecture and affects the structure, access, and processing of language and memory.

Successful acquisition and use of language requires the storage in memory of many words, their associated concepts, and grammatical rules. Access to these items in memory is accomplished with relative ease. The process by which language is stored, accessed, and processed is remarkable, yet becomes even more impressive when bilingualism is considered. A bilingual must not only store information pertaining to two languages, but also be able to access and process linguistic information according to changing linguistic contexts. The two languages have the potential to compete for memory resources and processing

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capacity. One way to avoid competitive interference would be for the bilingual architecture to include two systems that store, access, and process information in a language-specific manner. However, this characterization of the bilingual as the sum of two monolingual minds is inconsistent with a wealth of research that indicates high interactivity between the bilingual's two languages in memory and language processing (Grosjean, 1989). In the current chapter, we consider how multiple languages interact to influence memory storage, access, and processing. Whether memory is accessed selectively from one language or whether both languages are retrieved automatically has implications for long-term memory organization. Similarly, the way in which information is processed depends on what becomes activated during memory access, and how information is encoded and stored in long-term memory.

We begin by focusing on the structure of long- and short-term memory. Long-term memory is composed of substructures specific to knowledge categories, and the degree to which language-specific information is represented may differ between these categories. The manner in which information in short-term memory is processed by the working memory system is also discussed. Next, we examine how stored representations in long-term memory are accessed. Once again, we consider whether the language of retrieval affects recall success, indicating language-specific access, or whether both languages become activated automatically, indicating close integration between a bilingual's multiple languages. To address this question we examine access to episodic memory and retrieval of semantic knowledge during recognition and production of language. The chapter ends with a focus on how bilinguals process their two languages. We review the organization of several theoretical and computational models, and their capabilities in capturing aspects of bilingual language processing, after which we explore how bilingualism affects the ability to process and encode novel information, such as during novel language learning.

### Structure of bilingual memory

The primary division between types of memory is made according to the timescale over which information is retained. This separation has its origins in James' (1890) *Principles of Psychology*, which differentiated between primary memory for recent experiences and secondary memory for information retained over a long period of time. The distinction received renewed attention during the 1960s with the development of



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the field of cognitive psychology (Neisser, 1967) and its attempts to describe the information processing capabilities of the mind. Atkinson and Shiffrin (1968) defined short-term memory as an information-maintenance system that controlled access and encoding to long-term memory. Evidence for a separation between short- and long-term memories came from patients with amnesia, who seemed to display specific impairments to one of the two memory systems (Baddeley & Warrington, 1970; Milner, 1966). The underlying architectures of long- and short-term memory are debated, but there is agreement on their functional distinction. In this section, we will consider first the storage of language in long-term memory, and then the effect of language processing and information encoding in the short-term memory system.

### Long-term memory in bilinguals

Long-term memory (LTM) contains stable representations of knowledge acquired over time, including *explicit* memory for facts and events, and *implicit* memory for skills, routines, and associations. Explicit and implicit memory can be dissociated and appear to involve distinct neural components (Eichenbaum & Cohen, 2001; Mishkin, Malamut, & Bachevalier, 1984; Poldrack & Packard, 2003; Squire & Knowlton, 2000; Voss & Paller, 2008). They also differ with respect to how language is involved. Explicit memory can be consciously demonstrated by verbally recounting an event or by providing an answer to a query, while implicit memory can only be demonstrated as a non-conscious change in performance due to information gained over time. Both explicit and implicit memory play important roles in language acquisition and processing (Morgan-Short, 2007); implicit memory contributes to acquisition of grammar (Ullman, 2004), but explicit memory has been the focus of more extensive study in research on bilingual cognition (e.g., Kroll & de Groot, 1997; Pavlenko, 2000).

Explicit memory can be further divided into *semantic* memory for general facts, including word–meaning associations, and *episodic* memory for events and their linguistic environment. Memory models currently disagree on the specifics of semantic and episodic memory consolidation (the process by which information is encoded and stored in LTM). For example, *memory consolidation theory* (Paller, 1997; Scoville & Milner, 1957; Squire, Cohen, & Nadel, 1984) maintains that both semantic and episodic memories are formed by hippocampal binding of information across neocortical sites. Over time, the paired associations between neocortical sites strengthen, and the hippocampus is relied on less to reactivate memories (McClelland, McNaughton, &

O'Reilly, 1995; Norman & O'Reilly, 2003; Paller, 1997; Rempel-Clower *et al.*, 1996). Patients with hippocampal lesions are unable to consolidate new semantic and episodic memories but demonstrate preserved recall for facts and events prior to the injury, which are thought to be stored across neocortical sites. In contrast, the *multiple memory trace theory* separates the processes governing semantic and episodic memory storage (Moscovitch *et al.*, 2005; Nadel *et al.*, 2000; Rosenbaum *et al.*, 2005). Episodic memory is thought to always rely on the hippocampus for retrieval, whereas semantic memory is stored in the neocortex without hippocampal involvement (Levine *et al.*, 2002).

If semantic and episodic memories are stored independently, as the multiple memory trace theory suggests, then it is possible that they differ in whether they can mark memories for language assignment. Episodic memories are integrative and preserve a large amount of the encoding context across modalities. Language is inescapably part of this context, which may be reflected in language-specific encoding and retrieval of episodic memories. In contrast, semantic memory may forgo linking concepts to specific languages, forming targeted connections across neocortical sites. Overall, the structure of episodic and semantic memory opens the possibility for language-specific storage in the case of episodic memory and language-non-specific storage of semantic memory. Greater separation of languages in episodic memory can allow for easier access and processing in monolingual contexts and reduced interference from the non-target language. In a semantic memory system, language identity is determined during processing, after activating items in both languages. The degree to which patterns of lexical access and processing can reveal the structure of languages in LTM storage will be considered more carefully in subsequent sections.

### Short-term memory in bilinguals

Information that is stored in long-term memory must be accessed and transferred to short-term memory (STM) to be processed in a meaningful way to formulate output. STM is part of the working memory (WM) system, which additionally subsumes attentional and control units involved in information processing. The structure of bilingual memory places unique demands on WM, and appears to improve the efficiency with which the system operates, improving the bilingual's ability to maintain and encode novel information.

The first issue to consider is whether STM represents a distinct neural system compared LTM or whether the two rely on the same underlying architecture. This issue has implications for defining the structure